REMARKS/ARGUMENTS

This is a Response to the Office Action mailed March 30, 2004, in which a three (3) month Shortened Statutory Period for Response has been set, due to expire June 30, 2004. Enclosed is our check to cover the fee for a one-month extension of time, to July 30, 2004. Forty-three (43) claims, including twelve (12) independent claims, were paid for in the application. Claims 1, 21, 23-26, 28, 35, 39 and 42 have been canceled. Claims 2-5, 8-9, 22, 27, 29-31, 36-37, 40 and 43 have been amended. No new matter has been added to the application. No fee for additional claims is due by way of this Amendment. The Director is authorized to charge any fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090. Claims 2-20, 22, 27, 29-34, 36-38, 40-41 and 43 are pending.

Objections

Claim 8 was objected to because of an informality which is corrected by the amendments above.

Rejections Under 35 U.S.C. §102

Claims 11, 13, 16-17, 21 and 38 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,242,120 (hereinafter Herron).

Claims 11, 13-14, 16-21 and 33 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,569,549 (hereinafter Sawyer).

Claims 1-3, 25-26 and 28 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 3,935,028 (hereinafter Strasser et al.).

The disclosed embodiment of the invention will now be discussed in comparison to the cited references. Of course, the discussion of the disclosed embodiment, and the discussion of the differences between the disclosed embodiment and the subject matter described in the cited references, do not define the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner to appreciate important claim distinctions discussed thereafter.

Herron is generally directed toward optimizing fuel cell purge cycles. In particular, Herron teaches a fuel cell system 10 comprising a fuel cell stack 12 of one or more fuel cells 14, purge assembly 30 including at least one purge valve 32, controller 40, and sensor

42. *Herron*, Figure 1; col. 2, lines 57-60; col. 3, lines 36-54. Herron teaches that the controller 40 resets any residual or previously stored value of the measured process variable. *Herron*, Figure 2, step 50; col. 4, lines 28-29. The sensor 42 then measures a process parameter and communicates such process parameter to the controller 40. *Herron*, Figure 2, step 52; col. 4, lines 28-31. The controller 40 compares the value of the process parameter to a predetermined threshold value. *Herron*, Figure 2, step 54; col. 4, lines 36-37. If the value of the process parameter is larger than a predetermined threshold value the controller 40 activates the purge assembly 30 and restarts the process at step 50 (reset process parameter). *Herron*, col. 4, lines 36-43. If the value of the process parameter is not above the predetermined threshold, then steps 52-54, above, are repeated without first activating the purge assembly. *Herron*, col. 4, lines 41-43.

The Examiner characterized Herron as teaching that the "fuel cell is purged in pulsed manner until the value of the measured parameter is reduced below a threshold value." Office Action, page 2. However, it is important to recognize that Herron teaches that the duration of each purge is a *predetermined fixed* value. This is evidenced in a number of ways. For example, there is no discussion of deactivating the purge assembly or otherwise closing the purge valve. Herron, Figures 2 and 3. Also for example, Herron teaches that the prior art purged at a predetermined fixed frequency, and purged for a predetermined fixed duration. Herron, col. 1, line 50-col. 2, line 34. Herron noted that the problem to be solved was the predetermined fixed frequency of purging (*i.e.*, start of each purge), and otherwise did not identify or even recognize any problem associated with the use of a predetermined fixed duration for each purge (*i.e.*, length of each purge). Herron, col. 1, line 50-col. 2, line 34. Had some variable purge duration been intended, Herron would have explicitly stated such, particularly in light of Herron's clear description of the prior art and the problem to be solved.

Further, it is also important to recognize that the controller taught by Herron will activate the purge *once, each and every* time that the measured parameter meets the threshold condition. Thus, there is a one-to-one correspondence between the occurrence of the trigger condition (*i.e.*, measured parameter meets the threshold condition) and purge valve openings. There is no provision in Herron for multiple openings of the purge valve in response to a trigger condition. Further there is no provision in Herron for a lockout mechanism, such as an inter-purge duration, which defines a time during which the purge valve cannot be opened even if the trigger condition occurs.

Sawyer is generally directed towards optimizing a non-cascaded fuel cell system. The fuel cell system 10 taught by Sawyer comprises a fuel cell stack 12 consisting of one or more fuel cells, vent valve 30, vent valve controller 32, and optional sensor 34. *Sawyer*, Figure 3; col. 6, lines 6-16. Sawyer teaches two methods by which the operation of the fuel cell system may be optimized.

Figure 6 illustrates a first method in which the fuel cell stack 12 is purged for a predetermined fixed duration (*i.e.*, purge pulse duration) upon system start-up. *Sawyer*, Figure 6. During the entire predetermined fixed purge pulse duration, the vent valve 30 is open and fuel is provided to the fuel cells. *Sawyer*, col. 7, lines 48-58. At the end of the predetermined fixed purge pulse duration, the vent valve 30 is sealed and the fuel cell stack is run dead-ended for a predetermined length of time. *Sawyer*, col. 7, lines 59-63. At the conclusion of the predetermined duration of dead-ended operation, the vent valve 30 is opened and the operation cycle returns to step 130 to purge the contaminants and to provide a new pulse of fuel to the fuel cells. *Sawyer*, col. 8, lines 3-6. Thus, the frequency and duration of the purges are both predetermined fixed values. This method is referred to hereinafter as the timed method.

A second method illustrated in Figure 7 differs from the timed method discussed above, in that the fuel cell stack is run dead-ended until the sensor 34 detects a level of nitrogen above a predetermined threshold value. Upon such detection, the fuel cell stack is purged, and new fuel is provided as in the timed method. The fuel cells are then run dead-ended, and the cycle repeats. *Sawyer*, col. 8, lines 39-43. Thus, Sawyer teaches that the frequency of purges is a variable based on a threshold condition, while the duration of each purge is predetermined and fixed. This method is referred to hereinafter as the threshold method.

While Sawyer teaches the duration of this purge pulse is to be determined by the length of time required to for a sufficient volume to be purged, *Sawyer*, col. 6, lines 33-39, it is clear that this length of time is be "concretely established" by experimentation or analysis when designing the system. *Sawyer*, col. 6, lines 57-65. Thus, Sawyer does not teach determining the current through the fuel cell stack or determining the duration of the purge based on the determined current through the fuel cell stack.

Importantly, Sawyer makes no provision under either the timed or threshold methods for multiple openings of the purge valve in response to a single trigger condition. Nor does Sawyer make provision under either the timed or threshold methods for a lockout

mechanism, such as an inter-purge duration, which defines a time during which the purge valve cannot be opened even if the trigger condition occurs.

Strasser is generally directed towards a fuel cell system. The fuel cell system 10 comprises a control unit 11, fuel cells 16, 17, and discharge valves 63, 64. *Strasser*, col. 5 line 10 et seq.; col. 7, lines 30-31. The control unit compares the voltage across a last one of the fuel cells (*i.e.*, purge cell) to the average voltage across the fuel cells. When the voltage across the purge cell falls below a threshold percentage of the average voltage of the fuel cells, the purge valves 63, 64 are opened. *Strasser*, col. 5, lines 10 et seq. Strasser does not teach or suggest the manner in which the purge valves 63, 64 are closed. Like the previously discussed references, Strasser draws a one-to-one correspondence between the trigger condition and opening of the discharge valves, the frequency of purges based on the voltage comparison. Importantly, Strasser makes no provision for multiple openings of the purge valve in a purge cycle in response to the occurrence of one triggering event. Nor does Strasser make provision for a lockout mechanism, such as an inter-purge duration, which defines a time during which the purge cannot be activated even if the trigger condition occurs.

Claims 2 and 3 have been amended to depend from claim 5, and are thus discussed below in reference to the rejections under 35 USC 103.

Claim 11 recites, inter alia, "the pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once; and then keeping the valve closed for an inter-purge duration before any subsequent purge." Thus, the purge valve is opened more than once per purge sequence. The hold period defines the time between successive openings of the purge valve during a single purge sequence, while the inter-purge duration defines the time between successive purge sequences, ensuring that purge sequences do not occur too frequently, even in the presence of a triggering condition.

As discussed above, Herron teaches that that the controller will execute a predetermined fixed duration purge *each and every* time that the measured parameter meets the threshold condition. Thus, there is no provision in Herron for multiple openings of the purge valve per occurrence of a trigger condition. Nor is there provision in Herron for a lockout mechanism, such as an inter-purge duration.

The Examiner states that the "disclosure is considered to be anticipatory of the claimed "hold period between pulsed purges." The Examiner goes on to state that "[t]he purge

valve is subsequently kept closed for an inter-purge duration while the process parameter remains below the purge condition value." The combination of statements seems to blur the distinction between the two different terms. Clearly, Herron teaches purging at a variable frequency, the time between any two openings of the purge valves being dictated by the occurrence of the trigger condition (*i.e.*, parameter meets threshold). Whether this is denominated as the "hold time" or the "inter-purge duration" it can only correspond to one, not both, of the recited periods.

Thus, Herron does not teach or suggest the "the pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once; and then keeping the valve closed for an inter-purge duration before any subsequent purge" as recited in claim 11.

Also as discussed above, the Sawyer teaches a one-to-one correspondence between openings of the purge valve and occurrence of the triggering condition (*i.e.*, comparison of a process parameter with respect to a threshold condition). Thus, there is no provision in Sawyer for multiple openings of the purge valve per occurrence of a trigger condition. Nor is there provision in Herron for a lockout mechanism, such as an inter-purge duration, which defines a time during which the purge valves cannot be opened even if the purge triggering condition occurs.

Again the Examiner's statements seem to blur the distinction between the "hold period" and the "inter-purge duration" set out as separate elements in the claim. Sawyer teaches purging at a variable frequency, the time between any two openings of the purge valves being dictated by the occurrence of the trigger condition (i.e., comparison of process parameter with respect to threshold condition). Whether this is denominated as the "hold time" or the "inter-purge duration" it can only correspond to one, not both, of the recited periods.

Thus, Sawyer does not teach or suggest the "the pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once; and then keeping the valve closed for an inter-purge duration before any subsequent purge" as recited in claim 11. Thus, claim 11 was allowable as filed and has not been amended.

Claim 13 is dependent on claim 11, and further recites "the inter-purge duration is longer than each of the at least one purge duration and hold period in the pulsed purge sequence." Claim 13 further points out the distinction between the recited "hold period" and "inter inter-

purge duration" which were equated in the rejections of claim 11. As discussed above, neither Herron nor Sawyer teach an inter-purge duration, thus cannot be said to teach "the inter-purge duration is longer than each of the at least one purge duration and hold period in the pulsed purge sequence" as recited in claim 13. Thus, claim 13 was allowable as filed and has not been amended.

Claim 14 recites *inter alia*, "a controller coupled to provide control signals to the actuator to open the purge valve when a fuel cell stack purge condition exists and *to close the purge valve after a purge duration determined based on a flow of current* through the fuel cell stack." (Emphasis added.)

As discussed above, Sawyer teaches optimizing fuel cell performance by timed dead-ended operation, and by providing a one-to-one correspondence between the occurrence of a triggering condition and an opening of a purge valve. Sawyer teaches that the opening of the purge valve is for a single pulse of a predetermined duration. *Sawyer*, col. 4, lines 10-11; col. 6, lines 33-39; col. 6, lines 57-65. While Sawyer teaches the duration of this purge pulse is to be determined by the length of time required to for a sufficient volume to be purged, *Sawyer*, col. 6, lines 33-39, it is clear that this length of time is be "concretely established" by experimentation or analysis when designing the system. *Sawyer*, col. 6, lines 57-65. Thus, Sawyer does not teach closing the purge valve after a purge duration determined based on a flow of current through the fuel cell stack as recited by claim 14. The section (col. 7, lines 51 et seq.) relied on by the Examiner appears unrelated to this limitation. Thus, claim 14 was allowable as filed and has not been amended.

Claim 16 recites inter alia, "operating a purge valve in a pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once for a second purge duration; and then keeping the valve closed for an inter-purge duration before any subsequent purge."

As discussed above, Herron and Sawyer both teach a one-to-one correspondence between the occurrence of a trigger condition and purge valve openings. Thus, neither Herron nor Sawyer teach multiple purge valve openings per purge cycle. Also as discussed above, neither Herron nor Sawyer teach an inter-purge duration during which the purge valve will not be opened, even if the trigger condition occurs. Thus, neither Herron nor Sawyer teach "operating a purge valve in a pulsed purge sequence comprising: opening the valve for a purge duration;

closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once for a second purge duration; and then keeping the valve closed for an inter-purge duration before any subsequent purge" as recited in claim 16. Thus, claim 16 was allowable as filed and has not been amended.

Claim 17 is dependent on claim 16, and further recites "the inter-purge duration is longer than each of the at least one purge duration and hold period in the pulsed purge sequence."

Since neither Herron nor Sawyer teach an inter-purge duration, as discussed above, neither Herron nor Sawyer can teach that the inter-purge duration is longer than the hold period as recited in claim 17. Thus, claim 17 was allowable as filed and has not been amended.

Claim 18 is dependent on claim 16, and further recites that "the first purge duration is the same as the second purge duration."

As discussed above, Sawyer teaches a one-to-one correspondence between triggering events and the openings of the purge valves, thus Sawyer does not teach a purge sequence comprising first and a second purge duration where the length of the first purge duration is the same as the second purge duration. Thus, claim 18 was allowable as filed and has not been amended.

Claim 19 is dependent on claim 16, and further recites that "the first purge duration is different than the second purge duration." Sawyer does not teach a second purge duration within the same cycle. Thus, claim 19 was allowable as filed and has not been amended.

Claim 20 is dependent on claim 16, and further recites that "determining at least one of the first and the second purge durations based on a fuel cell stack current."

As discussed above, Sawyer teaches a one-to-one correspondence between triggering events and the openings of the purge valves, thus Sawyer does not teach a purge sequence comprising first and a second purge duration where the length of the first and the second purge durations are based on a fuel cell stack current. In fact, Sawyer makes clear that the length of the single opening of the purge valve during a purge sequence is concretely determined via experimentation or analysis during design of the system, thus cannot be based on the current being produced by the fuel cell stack. Thus, claim 20 was allowable as filed and has not been amended.

Claim 33 recites, inter alia, "determining a purge duration based on the determined current flow; ... closing the purge valve after the purge valve has been open for the determined purge duration."

As discussed above, Sawyer fails to teach or suggest closing the purge valve at a time determined by the current flow from the fuel cell stack. Sawyer, Sawyer, col. 4, lines 10-11; col. 6, lines 33-39; col. 6, lines 57-65. Thus, claim 33 was allowable as filed and has not been amended.

Claim 38 recites *inter alia*, "operating a purge valve in a pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once; and then keeping the valve closed for an inter-purge duration before any subsequent purge."

As discussed above, Herron teaches a one-to-one correspondence between triggering events and opening of the purge valve, hence Herron does not teach a purge sequence including multiple openings of the purge valve. As further discussed above, Herron does not teach or suggest an inter-purge duration. Consequently, Herron does not teach or suggest "operating a purge valve in a pulsed purge sequence comprising: opening the valve for a purge duration; closing the purge valve after the purge duration for a hold period; repeating the opening and closing of the valve at least once; and then keeping the valve closed for an inter-purge duration before any subsequent purge" as recited by claim 38. Thus, claim 38 was allowable as filed and has not been amended.

Rejections Under 35 U.S.C. § 103

Claims 35, 36 and 41 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Sawyer (U.S. Patent No. 6,569,549).

Claims 4, 6-10, 27, 31-32 and 39-40 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Strasser et al. (U.S. Patent No. 3,935,028).

Claims 1, 5, 12, 15, 22-25, 29-30, 34, 37 and 42-43 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Sawyer (U.S. Patent No. 6,569,549) in view of Strasser et al. (U.S. Patent No. 3,935,028).

Claim 5 has been rewritten in independent form and recites, *inter alia*, "to close the purge valve after a determined purge duration has elapsed, the determination of purge duration being based on a flow of current through the fuel cell stack."

As discussed above, Sawyer employs a fixed purge pulse duration which is "concretely established" by experimentation or analysis before operation of the system. *Sawyer*, col. 6, lines 57-65. Strasser is silent with respect to the duration during which the valves will remain open. Thus, neither Sawyer nor Strasser teach or suggest anything other than a fixed predetermined purge duration, let alone a duration that is based on the current flowing from the fuel cell stack, as recited by claim 5.

Claim 6 depends directly from claim 4 and indirectly from claim 5, and further recites "wherein the controller is further coupled to provide control signals to the actuator to close the purge valve when the average purge cell voltage rises above a defined second percentage of the average fuel cell voltage."

The Examiner suggests that using a second threshold would be obvious to one of ordinary skill in the art since the "artisan would be motivated to close the purge valve as quickly as possible in hopes of not purging viable reactant material out of the system." Office Action, page 7. However, Sawyer does *not* teach using a threshold for determining when to close the purge valve, but rather employs a fixed predetermined purge duration for determining when to close the purge valve.

Further, while the goal of conserving fuel may be worthy, there is no suggestion or motivation in the art for using a different threshold voltage for closing the valve than the threshold voltage used for opening the valve. Assuming *arguendo* that one skilled in the art were motivated to employ a threshold condition for closing the purge valve, it would seem that such an artisan would chose to not close the valve until the original voltage threshold for opening the valves is reached. This would ensure that the voltage across the fuel cell stack has returned to the desired level, which is the goal. Additionally, in so choosing, one of ordinary skill in the art may be concerned about avoiding undesirable oscillation (repeated openings and closings of valves). One of ordinary skill in the art would likely believe that opening the valve before returning to the first voltage threshold might repeatedly trigger the valve opening and closing.

Claims 7 and 8 are dependent on claim 6. Claim 7 further recites "the defined second percentage is different than the defined first percentage." Claim 8 further recites "wherein the defined second percentage is greater than the first percentage." As stated immediately above, there is no suggestion or motivation in the Strasser or the other references for using a threshold for determining when to close the valve, yet alone using two different threshold conditions, particular ones that are different percentages of the measured voltage.

Claim 29 has been rewritten in independent form and recites, *inter alia*, "determining a current flow through the fuel cell stack; determining a purge duration based on the determined current flow; closing the purge valve after the determined purge duration." As discussed above, neither Sawyer nor Strasser teach or suggest closing the purge valve at a time determined by the current flow, as recited by claim 29. In particular, Strasser is silent with respect to the time at which the valve is closed. Sawyer teaches that the purge duration is fixed and predetermined via experimentation or analysis during design of the system.

Claim 27 has been amended to depend on claim 29, as is allowable based on that dependency. Claim 27 further recites "wherein the purge valve is opened if the average purge cell voltage falls below 90 percent of the average fuel cell voltage." There is no teaching or suggestion in the art for employing such relationship between the average purge cell voltage and the average fuel cell voltage.

Claim 30 has been amended to depend on claim 29, as is allowable based on that dependency. Claim 30 further recites "wherein determining a purge duration based on the determined current flow comprises determining the purge duration based on a defined linear relationship between current flow and the purge duration." There is no teaching or suggestion in the art for employing a linear relationship between current flow and purge duration.

Claim 31 has been amended to depend on claim 29, as is allowable based on that dependency. Claim 31 further recites "closing the purge valve when the average purge cell voltage rises above a second defined percentage of the average fuel cell voltage." There is no teaching or suggestion in the art of a second defined percentage of the fuel cell voltage.

Claim 32 depends on claim 29, as is allowable based on that dependency. Claim 32 further recites "second defined percentage is different than the first defined percentage." There is no teaching or suggestion in the art for having different first and second percentages.

Claim 33 recites, *inter alia*, "determining a purge duration based on the determined current flow; ... closing the purge valve after the purge valve has been opened for the determined purge duration." For the reasons discussed above, Sawyer and Strasser fail to teach or suggest closing the purge valve at a time determined by the current flow, as recited by claim 33.

Claim 36 has been rewritten in independent form and recites, *inter alia*, "opening the purge valve for a determined purge duration . . . determining the determined purge duration during operation of the fuel cell stack based on a flow of current through the fuel cell stack." For

the reasons discussed, above, Sawyer fails to teach or suggest determining a purge duration based on the current flow from the fuel cell stack.

Claim 40 has been rewritten in independent form and recites, *inter alia*, "closing the purge valve when the average purge cell voltage rises above a second defined percentage of the average fuel cell voltage." As discussed above with regard to claim 6, Strasser fails to teach or suggest employing a threshold for determining when to close a purge valve. Strasser in fact, relies on a fixed predetermined purge duration. Further, Strasser fails to teach or suggest a second threshold for closing the purge valve in addition to a first threshold for closing the purge valve. In fact, as discussed above with reference to claim 6, even if one of ordinary skill in the art were motivated to employ a threshold for determining when to close the purge valve, the artisan would likely use a single threshold to both open and close the valve. Claim 40 has not been amended as was allowable as filed.

Claim 41 recites, *inter alia*, "determining a current flow through a fuel cell stack; determining a purge duration based on the determined current flow." As discussed above with regard to claim 14, Sawyer fails to teach or suggest closing the purge valve at a time determined by the current flow.

Claim 43 has been rewritten in independent form and recites, *inter alia*, "determining the determined purge duration based on a flow of current through the fuel cell stack." As discussed above, Sawyer and Strasser fail to teach or suggest closing the purge valve at a time determined by the current flow, as recited by claim 43. The rewriting of claim 43 has not narrowed the scope of claim, and thus claim 43 was allowable as originally filed.

Conclusion

Overall, the cited references do not singly, or in any motivated combination, teach or suggest the claimed features of the embodiments recited in independent claims 5, 11, 14, 16, 29, 33, 36, 38, 40-41 and 43, and thus such claims are allowable. Because the remaining claims depend from the allowable independent claims, and also because they include additional limitations, such claims are likewise allowable. If the undersigned attorney has overlooked a relevant teaching in any of the references, the Examiner is requested to point out specifically where such teaching may be found.

In light of the above amendments and remarks, Applicants respectfully submit that all pending claims are allowable. Applicants, therefore, respectfully request that the

Examiner reconsider this application and timely allow all pending claims. Examiner Crepeau is encouraged to contact Mr. Abramonte by telephone to discuss the above and any other distinctions between the claims and the applied references, if desired. If the Examiner notes any informalities in the claims, he is encouraged to contact Mr. Abramonte by telephone to expediently correct such informalities.

Respectfully submitted,

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